SOME OBSERVATIONS CONCERNING THE EFFECTS OF FREEZING ON INSECT LARVAE.*

JAMES S. HINE.

It has been known for a long time that some insect larvae can withstand low temperatures without being noticeably injured thereby. Also that there is great difference among species of insects, or in some cases even among the individuals of a single species, in regard to the minimum temperature at which life is endangered. Economic entomologists have now and then made the claim that frosts, especially when they occurred at certain seasons, have been important factors in the control of injurious species.

In 1893 while studying the life history and habits of a moth, Bellura obliqua, which passes its larval stage in the stems of the cat-tail reed, Typha latifolia, I had an opportunity to make some observations on larvae of this species which are normally found in the reeds throughout the winter. The winter was rather severe for the latitude of Columbus where the observations were made, and from January 10 to January 20, the temperature dropped below zero every night, varying from −2 Fahr. on the 10th, to −17 on the 17th. Large numbers of the larvae were collected during this interval, some during each day, and with the specimens some tests were made. Three larvae collected on the 14th, were placed in water and placed outside on a porch roof during 12 hours the following night when the minimum temperature recorded was −15. The next morning the specimens were brought inside and thawed out, after which they were taken from the water and kept in a tin box at the temperature of a living room for about 12 hours. These same larvae received the same treatment for six consecutive nights and days, during the time withstanding a minimum temperature of −11 on the

* Read before the Ohio Academy of Science, Nov. 30, 1907.

15th, –6 on the 16th, –17 on the 17th, –6 on the 18th, –14 on the 19th, and –16 on the 20th. None of the specimens showed signs of injury from the treatment.

Three other larvae taken on the 14th, and treated exactly as the above except that water was not used received no noticeable injury.

Three larvae taken on the 14th, and frozen in water and kept at outdoor temperature for a week fully revived when thawed out again.

Larvae collected just after daylight on January 20, when the thermometer registered –15 could be snapped in two almost like icicles and crystals of ice were observed within their body cavities. Some of these pieces were alive when thawed out at the end of a week.

Under natural conditions the larvae were to be found wherever they happened to be when freezing temperature caught them. Some in the centers of the reeds, some protected by only one or two thin leaf-sheaths, some at distances above the snow ranging from an inch or two up to two feet, or even more, and some beneath the surface of the ground near the roots of the plants.

In order to bring out a striking difference in results I wish to give my observations on the larvae of the common Hawk-moths of the tomato, two species of which are about equally common in the state. During the Fall of 1896 these larvae were abundant on tomatoes and when time for the first frosts arrived not all the specimens had reached the mature larval condition and entered the ground for pupation. Larvae of different sizes therefore were observed feeding actively on the tomato vines the day before the first frost came. The frost was not a hard one but the exposed parts of the vines were killed as were the larvae on these parts. Larvae on the parts of the vines that were not killed kept on feeding the following day, but a frost the next night killed most of the leaves that had escaped the previous night and with them the remaining larvae.

Previous to 1903, for several years canker worms were abundant on the elm trees along the river on the Ohio State University farm. During April of 1903 the warm weather hatched the eggs of the Fall Canker-worm and the larvae started in to cause havoc among the elm leaves, but a frost on May 4, killed so many of them that they have not been a serious pest since. It may be stated that A. F. Burgess made a similar observation in regard to the Spring Canker-worm on apple the same Spring, and those who have observed know that the latter species has not done the damage since 1903 that it did the few years previous to that year.

A quotation from an account of Sir John Ross's second arctic voyage recording experiments carried out with a moth, Laria rossi, has a bearing here:

"About thirty of the caterpillars were put into a box in the middle of September, and after being exposed to the severe winter temperature of the next three months, they were brought into a warm cabin, where, in less than two hours, every one of them returned to life, and continued for a whole day walking about. They were again exposed to the air at a temperature of about −40, and became hard frozen immedately; in this state they remained a week, and on being brought into the cabin again, only 23 came to life. At the end of four hours these were put out once more, and hard frozen again; after another week they were brought in, when only 11 were restored to life. A fourth time they were exposed to the winter temperature, and only two returned to life on being brought into the cabin again. These two survived the winter and in May an imperfect moth was produced from one, and six parasitic flies from the other."

From what has been said it is evident that some larvae will not be killed by very low temperatures, while others may be killed by a frost that is sufficient to kill tender foliage, also that all the difference is not in the species, for some specimens may be killed while others of the same species are not killed by the same exposure.

P. Bachmetjew of Bulgaria, has published an extended paper in *Zeitschrift fur wissenschaftliche Zoologie* for 1899, from which the following conclusions are extracted:

"The thawing out of insects after their body fluids have been frozen has no noticeable influence upon their return to life, but only upon the intensity of their vitality."

"The critical point is not the same in different species, nor in different individuals of the same species."

"The longer an insect has gone without food, the lower is the normal freezing point of its body fluids."

"Repeated freezing lowers the critical point and also the normal freezing point of the body fluids."